

CLAIMS

1. A brain current source estimating method for estimating, based on an electromagnetic field observed outside a scalp, a position of a current source as a source of said electromagnetic wave existing in the brain, comprising the steps of:

5 setting, in the brain, a plurality of virtual curved surfaces having depths from brain surface different from each other and shapes not intersecting with each other, and setting lattice points on each of said virtual curved surfaces;

10 estimating, on each of said virtual curved surfaces, a current distribution for recovering said observed electromagnetic field; and

15 based on an expansion of the current distribution estimated on said virtual curved surfaces and a difference between the electromagnetic field recovered based on said current distribution and said observed electromagnetic field, identifying a virtual curved surface at which said expansion and said difference attain relative minimums among said plurality of virtual curved surfaces as a true curved surface on which said current source exists.

2. The brain current source estimating method according to claim 1, wherein said step of estimating said current distribution includes the step of

20 determining posterior probability by Bayesian estimation method from prior distribution and observation data of said electromagnetic field; and

 said step of identifying as a true curved surface on which said current source exists includes the step of

25 identifying a virtual curved surface of which corresponding said posterior probability attains the maximum, among said virtual curved surfaces.

3. The brain current source estimating method according to claim 2, wherein said step of estimating a current distribution includes the step of

identifying a first virtual curved surface closest to said brain surface and having posterior probability attaining a relative maximum, among said plurality of virtual surfaces, while successively moving from a virtual curved surface on the side of the brain surface to a deeper side; and

5 said step of identifying a curved surface as a true curved surface on which said current source exists includes the steps of

identifying a localized current distribution corresponding to a point of relative maximum of said current distribution, on said first virtual curved surface,

10 separating a plurality of local surfaces each including said localized current distribution, and

fixing, among said plurality of local surfaces, local surfaces other than a local surface as an object of identification, moving said local surface as an object of identification in the depth direction, and identifying positions where said posterior probability attains the relative maximum, successively from the side closer to said brain surface.

4. The brain current source estimating method according to claim 3, wherein in said step of estimating a current distribution, said current distribution is estimated with a first spatial resolution;

20 said method further comprising the step of
re-estimating said current distribution with a second spatial resolution higher than said first resolution and resolution of said plurality of virtual curved surfaces in the depth direction being improved.

25 5. The brain current source estimating method according to claim 1, wherein said step of estimating a current distribution includes the step of
setting, when said current distribution is estimated in accordance with Bayesian estimation, a hierarchical prior distribution in said Bayesian estimation using observation

data obtained by other observation method independent of said observation of electromagnetic field for said estimation of the current source.

5 6. A program for a computer for estimating, based on an electromagnetic field observed outside a scalp, a position of a current source as a source of said electromagnetic wave existing in the brain, to have the computer execute the steps of:

 setting, in the brain, a plurality of virtual curved surfaces having depths from brain surface different from each other and shapes not intersecting with each other, and setting lattice points on each of said virtual curved surfaces;

10 estimating, on each of said virtual curved surfaces, a current distribution for recovering said observed electromagnetic field; and

 based on an expansion of the current distribution estimated on said virtual curved surfaces and a difference between the electromagnetic field recovered based on said current distribution and said observed electromagnetic field, identifying a virtual
15 curved surface at which said expansion and said difference attain relative minimums among said plurality of virtual curved surfaces as a true curved surface on which said current source exists.

20 7. The program according to claim 6, wherein said step of estimating said current distribution includes the step of determining posterior probability by Bayesian estimation method from prior distribution and observation data of said electromagnetic field; and

 said step of identifying as a true curved surface on which said current source exists includes the step of

25 identifying a virtual curved surface of which corresponding said posterior probability attains the maximum, among said virtual curved surfaces.

8. The program according to claim 7, wherein

said step of estimating a current distribution includes the step of
identifying a first virtual curved surface closest to said brain surface and having
posterior probability attaining a relative maximum, among said plurality of virtual
surfaces, while successively moving from a virtual curved surface on the side of the
5 brain surface to a deeper side; and

said step of identifying a curved surface as a true curved surface on which said
current source exists includes the steps of

identifying a localized current distribution corresponding to a point of relative
maximum of said current distribution, on said first virtual curved surface,

10 separating a plurality of local surfaces each including said localized current
distribution, and

fixing, among said plurality of local surfaces, local surfaces other than a local
surface as an object of identification, moving said local surface as an object of
identification in the depth direction, and identifying positions where said posterior
15 probability attains the relative maximum, successively from the side closer to said brain
surface.

9. The program according to claim 8, wherein
in said step of estimating a current distribution, said current distribution is
20 estimated with a first spatial resolution;

said method further comprising the step of
re-estimating said current distribution with a second spatial resolution higher
than said first resolution and resolution of said plurality of virtual curved surfaces in the
depth direction being improved.

25 10. The program according to claim 6, wherein
said step of estimating a current distribution includes the step of
setting, when said current distribution is estimated in accordance with Bayesian

estimation, a hierarchical prior distribution in said Bayesian estimation using observation data obtained by other observation method independent of said observation of electromagnetic field for said estimation of the current source.

5 11. A brain current source estimating apparatus for estimating, based on an electromagnetic field observed outside a scalp, a position of a current source as a source of said electromagnetic wave existing in the brain, comprising:

 virtual curved surface setting means for setting, in the brain, a plurality of virtual curved surfaces having depths from brain surface different from each other and shapes
10 not intersecting with each other, and setting lattice points on each of said virtual curved surfaces;

 current distribution estimating means for estimating, on each of said virtual curved surfaces, a current distribution for recovering said observed electromagnetic field; and

15 current source identifying means for identifying, based on an expansion of the current distribution estimated on said virtual curved surfaces and a difference between the electromagnetic field recovered based on said current distribution and said observed electromagnetic field, a virtual curved surface at which said expansion and said
20 difference attain relative minimums among said plurality of virtual curved surfaces as a true curved surface on which said current source exists.

 12. The brain current source estimating apparatus according to claim 11, wherein

 said current distribution estimating means includes

25 posterior probability determining means for determining posterior probability by Bayesian estimation method from prior distribution and observation data of said electromagnetic field; and

 said current source identifying means includes

virtual curved surface identifying means for identifying a virtual curved surface of which corresponding said posterior probability attains the maximum, among said virtual curved surfaces.

5 13. The brain current source estimating apparatus according to claim 12, wherein

 said current distribution estimating means includes

 shallowest virtual curved surface identifying means for identifying a first virtual curved surface closest to said brain surface and having posterior probability attaining a
10 relative maximum, among said plurality of virtual surfaces, while successively moving from a virtual curved surface on the side of the brain surface to a deeper side; and

 said current source identifying means includes

 localized current distribution identifying means for identifying a localized current distribution corresponding to a point of relative maximum of said current distribution,
15 on said first virtual curved surface,

 local surface extracting means for separating a plurality of local surfaces each including said localized current distribution, and

 local surface position identifying means for fixing, among said plurality of local surfaces, local surfaces other than a local surface serving as an object of identification,
20 moving said local surface as an object of identification in the depth direction, and identifying positions where said posterior probability attains the relative maximum, successively from the side closer to said brain surface.

25 14. The brain current source estimating apparatus according to claim 13, wherein

 said current distribution estimating means estimates said current distribution with a first spatial resolution and thereafter re-estimates said current distribution with a second spatial resolution higher than said first resolution and resolution of said plurality

of virtual curved surfaces in the depth direction being improved.

15. The brain current source estimating apparatus according to claim 11,
wherein

5 said current distribution estimating means includes means for setting, when said
current distribution is estimated in accordance with Bayesian estimation, a hierarchical
prior distribution in said Bayesian estimation using observation data obtained by other
observation method independent of said observation of electromagnetic field for said
estimation of the current source.

10 16. A recording medium recording a computer program for estimating, based
on an electromagnetic field observed outside a scalp, a position of a current source as a
source of said electromagnetic wave existing in the brain, said program comprising the
steps of:

15 setting, in the brain, a plurality of virtual curved surfaces having depths from
brain surface different from each other and shapes not intersecting with each other, and
setting lattice points on each of said virtual curved surfaces;

 estimating, on each of said virtual curved surfaces, a current distribution for
recovering said observed electromagnetic field; and

20 based on an expansion of the current distribution estimated on said virtual
curved surfaces and a difference between the electromagnetic field recovered based on
said current distribution and said observed electromagnetic field, identifying a virtual
curved surface at which said expansion and said difference attain relative minimums
among said plurality of virtual curved surfaces as a true curved surface on which said
25 current source exists.

17. The recording medium according to claim 16, wherein
said step of estimating said current distribution includes the step of

determining posterior probability by Bayesian estimation method from prior distribution and observation data of said electromagnetic field; and

said step of identifying as a true curved surface on which said current source exists includes the step of

5 identifying a virtual curved surface of which corresponding said posterior probability attains the maximum, among said virtual curved surfaces.

18. The recording medium according to claim 17, wherein

said step of estimating a current distribution includes the step of

10 identifying a first virtual curved surface closest to said brain surface and having posterior probability attaining a relative maximum, among said plurality of virtual surfaces, while successively moving from a virtual curved surface on the side of the brain surface to a deeper side; and

15 said step of identifying a curved surface as a true curved surface on which said current source exists includes the steps of

identifying a localized current distribution corresponding to a point of relative maximum of said current distribution, on said first virtual curved surface,

separating a plurality of local surfaces each including said localized current distribution, and

20 fixing, among said plurality of local surfaces, local surfaces other than a local surface serving as an object of identification, moving said local surface as an object of identification in the depth direction, and identifying positions where said posterior probability attains the relative maximum, successively from the side closer to said brain surface.

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19. The recording medium according to claim 18, wherein

in said step of estimating a current distribution, said current distribution is estimated with a first spatial resolution;

said method further comprising the step of
re-estimating said current distribution with a second spatial resolution higher
than said first resolution and resolution of said plurality of virtual curved surfaces in the
depth direction being improved.

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20. The recording medium according to claim 16, wherein
said step of estimating a current distribution includes the step of
setting, when said current distribution is estimated in accordance with Bayesian
estimation, a hierarchical prior distribution in said Bayesian estimation using observation
data obtained by other observation method independent of said observation of
electromagnetic field for said estimation of the current source.

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